Name BETH "KEY" Period _____

Chemical Kinetics Refresher Worksheet

1. (a) What is meant by the term reaction rate? THE CHANGE IN CONCENTRATION / UNIT TIME
   (b) Name three factors that can affect the rate of a chemical reaction? TEMPERATURE / CONCENTRATION / SURFACE AREA
   (c) What information is necessary to relate the rate of disappearance of reactants to the rate of appearance of products? THE MOLE RATIO FROM THE BALANCED EQUATION

2. Consider the hypothetical aqueous reaction A(aq) → B(aq). A flask is charged with 0.065 mol of A in a total volume of 100.0 mL. The following data are collected:

Time (min)	0	10	20	30	40
Moles of A	0.065	0.051	0.042	0.036	0.031

(a) Calculate the number of moles of B at each time in the table. Assume there are no molecules of B at time zero.
(b) Calculate the average rate of disappearance of A for each 10-minute interval, in units of mol/s.
(c) Between t = 10 min and t = 30 min, what is the average rate of disappearance of B in units of M/s? Assume that the volume of the solution is constant.

a)

TIME (MIN)	0	10	20	30	40
MOLES OF B	0	0.014	0.023	0.029	0.034

b)

Time (min)	0-10	10-20	20-30	30-40
RATE =	$-\frac{(0.051\text{mol} - 0.065\text{mol})}{600\text{s}}$	$-\frac{(0.042 - 0.051)}{600\text{s}}$	$-\frac{(0.036 - 0.042)}{600\text{s}}$	$-\frac{(0.031 - 0.036)}{600\text{s}}$
	$= 2.3 \times 10^{-5}$ mol/s	$= 1.5 \times 10^{-5}$ mol/s	$= 1.0 \times 10^{-5}$ mol/s	$= 8.3 \times 10^{-6}$ mol/s

c) $$\frac{\left[\left(\frac{0.029\text{mol}}{0.1000\text{L}}\right) - \left(\frac{0.014\text{mol}}{0.1000\text{L}}\right)\right]}{(20\text{min} \times 60\text{s}/1\text{min})} = 1.25 \times 10^{-4}\text{M/s} = 1.3 \times 10^{-4}\text{M/s}$$

3. The isomerization of methyl isonitrile, CH_3NC, to acetonitrile, CH_3CN, was studied in the gas phase at 215°C, and the following data were obtained:

Time (s)	$[CH_3NC]$ (M)
0	0.0165
2000	0.0110
5000	0.00591
8000	0.00314
12000	0.00137
15000	0.00074

Calculate the average rate of reaction between, in M/s, for the time interval between each measurement.

$$\text{Rate} = -\frac{(0.0110\text{M} - 0.0165\text{M})}{(2000\text{s} - 0\text{s})} = 2.75 \times 10^{-6}\text{M/s}$$

$$\text{Rate} = -\frac{(0.00591\text{M} - 0.0110\text{M})}{(5000\text{s} - 2000\text{s})} = 1.70 \times 10^{-6}\text{M/s}$$

$$\text{Rate} = -\frac{(0.00314\text{M} - 0.00591\text{M})}{(8000\text{s} - 5000\text{s})} = 9.23 \times 10^{-7}\text{M/s}$$

$$\text{Rate} = -\frac{(0.00137\text{M} - 0.00314\text{M})}{(12000\text{s} - 8000\text{s})} = 4.43 \times 10^{-7}\text{M/s}$$

$$\text{Rate} = -\frac{(0.00074\text{M} - 0.00137\text{M})}{(15000\text{s} - 12000\text{s})} = 2.1 \times 10^{-7}\text{M/s}$$

5. For each of the following gas-phase reactions, indicate how the rate of disappearance of each reactant is related to the rate of appearance of each product:
(a) $H_2O_2(g) \rightarrow H_2(g) + O_2(g)$
(b) $2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$
(c) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

a) The rate of appearance for H_2 & O_2 = rate of disappearance of H_2O.

b) The rate of appearance for N_2 = rate of disappearance of N_2O.
The rate of appearance for O_2 is $\frac{1}{2}$ rate of disappearance of N_2O.

c) The rate of appearance for NH_3 is twice the rate of disappearance of N_2.
H_2 disappears at 1.5 times the rate NH_3 appears.

6. (a) Consider the combustion of $H_2(g)$: $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$. If hydrogen is burning at the rate of 4.6 mol/s, what is the rate of consumption of oxygen? What is the rate of formation of water vapor?
(b) The reaction $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$ is carried out in a closed vessel. If the partial pressure of NO is decreasing at the rate of 30 torr/min, what is the rate of change of the total pressure of the vessel?

a) $4.6 \text{ mol/s} \times \frac{1 \text{ mol } O_2}{2 \text{ mol/s } H_2} = 2.3 \text{ mol/s } O_2$

$4.6 \text{ mol/s } H_2 \times \frac{2 \text{ mol/s } H_2O}{2 \text{ mol/s } H_2} = 4.6 \text{ mol/s } H_2O$

b) Pressure due to NO decreases at 30 torr/min.
+ Pressure due to Cl_2 decreases at 15 torr/min.
Total pressure decrease = 45 torr/min

Pressure due to NOCl increases at 30 torr/min

$(\downarrow 45 \text{ torr/min}) + (\uparrow 30 \text{ torr/min}) = \downarrow 15 \text{ torr/min}$